Exhibit R-2, RDT&E Budget Item Justification	DATE February 2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology

(U) B. Program Change Summary ($ in Millions)

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	96.912	60.124	65.892	72.085
(U)	Current PBR/President's Budget	105.557	89.839	60.915	67.221
(U)	Total Adjustments	8.645	29.715		
(U)	Congressional Program Reductions		-0.087		
	Congressional Rescissions		-0.798		
	Congressional Increases		30.600		
	Reprogrammings	9.415			
	SBIR/STTR Transfer	-0.770			

(U) Significant Program Changes:

Not Applicable.

C. Performance Metrics

(U) Under Development.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2005

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT NUMBER AND TITLE: 2181 Spacecraft Payloads

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
2181 Spacecraft Payloads	32.515	26.787	18.966	18.891	25.562	28.339	30.106	30.663	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project funds the development, demonstration, and evaluation of radiation-hardened space electronic hardware, satellite control hardware and software for advanced satellite surveillance operations, and development of advanced laser communications technologies to support next generation satellite communications systems. Improved space-qualifiable electronics and software for data and signal processing will be more interchangeable, interoperable, and standardized. In the near-term, this project's work concentrates on converting (i.e., radiation-hardening) commercial data and signal processor technologies for use in Air Force space systems. For mid-term applications, the Improved Space Computer Program will merge advanced, radiation-hardened space processor, memory, and interconnect technologies with commercially-derived, open system architectures to develop and demonstrate robust, on-board processing capabilities for 21st century Department of Defense satellites. In the long-term, this project area focuses on developing low-cost, easily modifiable software and hardware architectures for fully autonomous constellations of intelligent satellites capable of performing all mission related functions without operator intervention.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
	8.733	9.744	9.507	10.822

(U) MAJOR THRUST: Develop spacecraft microelectronic devices, including radiation-hardened data processors and ultra-high density strategically hardened memories, space-qualifiable, high density advanced packaging technology, and micro-electro-mechanical systems (MEMS) components and applications.

(U) In FY 2004: Demonstrated functional elements for general-purpose processor at 500 million instructions per second and digital signal processors at one million operations per second. Developed architectures and designed electronics circuits in support of adaptable, self-repairing processors and memories. Demonstrated functional elements of chalcogenide-based field programmable logic and analog microelectronics. Developed hardened-by-design primitive cell libraries enabling the use of state-of-the-art commercial manufacturing plants for high performance, low-cost digital and mixed signal electronics. Built MEMS and chalcogenide-based switches supporting multi-switch box applications to smart-wiring manifolds. Designed the functional hardened by design and architecture elements of the miniaturized military global positioning system receiver.

(U) In FY 2005: Initiate the development of a general-purpose processor at 500 million instructions per second and digital signal processors at one million operations per second. Demonstrate electronics circuits in support of adaptable, self-repairing processors and memories enabling spacecraft capable of autonomously adapting to new missions. Build functional elements of chalcogenide-based field programmable logic and analog microelectronics. Develop hardened by design macrocell libraries enabling the use of state-of-the-art commercial manufacturing plants for high performance, low-cost

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electronics. Demonstrate elements for hieratical smart-wiring manifolds capable of reconfiguring entire space asset subsystems. Implement the hardened-by-design mixed signal library and the design for analog-to-digital converter demonstration; fabricate devices in the Silicon Germanium process. Validate performance and environmental ruggedness of the miniaturized military global positioning system (GPS) receiver through initial logic block engineering model.

(U) In FY 2006: Develop and validate the building blocks for a general-purpose processor at 500 million instructions per second and digital signal processors at one million operations per second. Provide the set of design tools for integrating hardening by design into commercial design tools. Fabricate a 16 megabyte chalcogenide-based nonvolatile memory. Fabricate the first design hardened structured application specific integrated circuit (ASIC) to implement increased ASIC performance on low cost devices. Design and fabricate the initial test vehicle to demonstrate the miniaturized military GPS receiver performance on low-cost devices.

(U) In FY 2007: Complete engineering model of the high performance 500 million instruction per second general-purpose processor. Fabricate a high performance design hardened analog-to-digital converter (ADC) for use in space and fabricate a very low-power ADC using advanced design cells and design hardening. Fabricate the miniaturized military GPS receiver for use on terrestrial, aero, and space platforms. Fabricate the building blocks for a very high performance ten million-gate design hardened field programmable gate array.

(U)

(U)	MAJOR THRUST: Develop intelligent satellite system technologies for responsive spacecraft operations and for satellite control, precision navigation, formation flying, and proximity operations technologies for spacecraft constellations.	2.803	2.783	2.607	2.685

(U) In FY 2004: Expanded the development of command, control, and navigational capability for high fidelity spacecraft proximity operations with application to counterspace operations. Completed development of automated planning and scheduling software for multiple satellites and the spacecraft and simulation data archiving and storage system. Expanded development of guidance, navigation, and control algorithms for proximity operations and large deployable systems. Developed initial command and telemetry simulation for mission operations center testing. Enhanced development of autonomous software technologies for responsive space systems.

(U) In FY 2005: Advance development of command, control, and navigational capability for high fidelity spacecraft proximity operations with application to counterspace operations. Complete development of guidance, navigation, and control algorithms for proximity operations and large deployable systems. Further command and telemetry simulation development for mission ops center testing. Integrate hardware-in-the-loop engineering development unit into testbed, interface with spacecraft command and

telemetry simulations, and begin mission ops center testing. Refine autonomous software technologies for responsive space systems. Design integrated distributed aperture sensor analysis tool for engineering level, mission/engagement and campaign level analyses, identifying modules required for implementing unique distributed aperture sensor features to be incorporated into existing modeling and simulation tools.

(U) In FY 2006: Validate command and control capabilities and guidance, navigation, and control algorithms for proximity operations with flight experiment data. Refine command, control, guidance, and navigational capabilities for counterspace to apply to space situational awareness and offensive/defensive operations. Complete command and telemetry simulation development for mission ops center testing. Complete integration of hardware-in-the-loop engineering development unit into testbed, interface with spacecraft command and telemetry simulations, and conduct mission ops center testing. Build unique distributed aperture sensor simulation modules for engineering level, mission/engagement and campaign level analysis tool.

(U) In FY 2007: Continue to refine command, control, guidance, and navigational capabilities for counterspace to apply to space situational awareness and offensive/defensive operations. Begin to integrate autonomous flight software technologies with command, control, guidance, and navigation technologies to support responsive space systems. Extend hardware-in-the-loop testbed, spacecraft command and telemetry simulations, and mission ops center to development and testing of responsive and tactical space systems. Integrate modules and complete distributed aperture sensor analysis tool for engineering level, mission/engagement and campaign level analyses.

(U)

(U) MAJOR THRUST: Develop modeling, simulation, and analysis tools and data exploitation methodologies for space-based surveillance systems, space capability protection technologies, access/mobility technologies, and flight experiments. Note: In FY 2006, reduction due to higher Air Force priorities.	0.965	0.923	0.692	1.199

(U) In FY 2004: Refined models for radio frequency (RF) system simulation to support systems engineering. Further developed models of RF signal processing. Refined simulation models of space-based surveillance systems for military utility analysis. Developed initial modeling, simulation, and analysis tools for technical assessment of space capability protection and access/mobility technologies. Developed first generation of physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis applicable to potential flight experiments.

(U) In FY 2005: Complete development of models for RF system simulation. Complete development of RF signal processing models. Expand development of simulations of space-based surveillance systems for

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	military utility analysis. Refine development of modeling, simulation, and analysis tools for technical assessment of space capability protection and access/mobility technologies. Continue to develop physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis applicable to potential flight experiments.				
(U)	In FY 2006: Further expand development of models of surveillance systems for military utility to include tactical surveillance and electro-optical technologies. Initiate model development of responsive and reconfigurable technologies. Refine development of physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis for flight experiments in tactical and responsive satellites.				
(U)	In FY 2007: Complete development of models of surveillance systems for military utility to include tactical surveillance and electro-optical technologies. Continue to develop models of responsive and reconfigurable technologies. Apply physics-to-engineering-to-engagement level models for systems engineering, tech trades, mission planning and operations, and utility analysis to flight experiments in tactical and responsive satellites.				
(U)					
(U)	MAJOR THRUST: Develop advanced space infrared technology and hardened focal plane detector arrays to enable acquisition, tracking, and discrimination of hot targets, as well as "cold body" targets such as decoys, satellites, and midcourse warheads.	3.257	2.286	2.175	2.638
(U)	In FY 2004: Characterized higher operating temperature, mid-wave infrared focal plane arrays (FPA). Completed fabrication and characterization of higher operating temperature, mid-wave infrared FPAs. Completed fabrication and characterization of first-ever dual band (mid-wave, long-wave) FPAs having an extended long-wave infrared response. Investigated radiation hardened-by-design (RHBD) development for long wavelength infrared FPAs for space-based passive surveillance applications. Explored detector interfacing concepts for larger-format, higher capability space hyperspectral imaging systems.				
(U)	In FY 2005: Complete pathfinder, dual-band (mid-wave, long-wave) FPA performance characterization and transition plan for insertion into a potential hyperspectral demonstration. Investigate detector array and cryogenic detector multiplexer interfacing concepts that lead to improved, larger-format, space hyperspectral imaging capabilities. Extend performance of single and dual color FPAs from moderate background levels to more stressing lower background levels needed for operation in space sensing.				
(U)	In FY 2006: Initiate assessment of large format Read Out Integrated Circuits, designed through RHBD, and fabricated on existing foundries. Investigate the readout and greater focal plane array performance enhancements needed for emerging detector array technologies.				
(U)	In FY 2007: Initiate studies for detectors and readouts needed for laser-based surveillance. Continue				

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	investigation into readouts fabricated on existing foundries and radiation hard design principles.				
(U)					
(U)	MAJOR THRUST: Develop and demonstrate satellite antenna technologies that exploit advanced electronic integration, high-density interconnects/packaging and advanced phased array component technologies to create large, lightweight space antennas. Note: This work was terminated at the end of FY 2004 due to higher priorities.	1.430	0.000	0.000	0.000
(U)	In FY 2004: Delivered flight-ready multi-beam, wide-bandwidth antenna modules for airborne multi-mode flight experiment. Redesigned baseline antenna module tiles using advanced substrate material to reduce antenna module weight by 25%. Developed and demonstrated ten milliwatt advanced low power, octave-wide bandwidth, low noise amplifier. Applied Application Specific Integrated Circuit technology to achieve a higher level of integration for the transmit-receive cells, reducing discrete components by 25%. Redesigned antenna tile architecture to incorporate next generation miniaturized phased array components to support eight simultaneous beams. Designed multi-decade-bandwidth antenna architecture.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop technologies for multi-access laser communications space terminals with reduced weight, power, and cost for transformational communications. Note: In FY 2004, there was an increased emphasis on laser communications space terminal development.	10.709	1.846	2.124	1.334
(U)	In FY 2004: Investigated component integration issues and identified technical challenges for potential space experiments of multi-access laser communications systems. Developed initial ground breadboard testbed. Completed space-based laser communications architecture studies.				
(U)	In FY 2005: Explore component integration issues of multi-access laser communications systems. Complete ground breadboard testbed. Test breadboard terminal designs in approved compatibility testbed. Develop initial multi-access laser communications terminal brassboard development.				
(U)	In FY 2006: Start development of components toward space-qualification and brassboard integration. Continue development of multi-access laser communications terminal brassboard. Start testing of components/system in relevant environmental.				
(U)	In FY 2007: Finalize brassboard integration. Begin identification and design of suitable space experiments. Begin development and qualification testing of flight hardware.				
(U)					
(U)	MAJOR THRUST: Develop satellite payload subsystem technologies to exhibit revolutionary	1.982	0.000	0.000	0.000

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	capabilities in operability, responsiveness, and cost-effectiveness. Note: In FY 2005, this effort has been moved to Project 682J.				
(U)	In FY 2004: Developed enabling responsive spacecraft technologies, which include on-the-fly programmable, configurable, logic, and modular, reusable, self-initiating software, as well as technologies that enable rapid satellite integration and minimum time on-orbit satellite checkout.				
(U)	In FY 2005: Not Applicable.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	MAJOR THRUST: Develop spectral/polarimetric sensing and data exploitation demonstrations for military imaging and remote sensing applications. Note: In FY 2005, advanced efforts from PE 0602601F, Space Technology.	0.000	0.185	1.861	0.213
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop concepts for electro-optical/infrared spectral polarimetric space demonstrations. Examine hardware issues and begin technology development plan. Begin development of polarimetric FPA technology.				
(U)	In FY 2006: Complete polarimetric FPA test article and validate performance. Integrate FPA into laboratory camera and collect high quality data in the laboratory of relevant materials.				
(U)	In FY 2007: Conduct field collection with polarimetric focal plane camera. Demonstrate feasibility of hardware design for transition to acquisition system.				
(U)					
(U)	CONGRESSIONAL ADD: Alternating Current (AC) Coupled Interconnect.	1.172	0.991	0.000	0.000
(U)	In FY 2004: Using previously established and proven principles, provided a system level demonstration of a non-conductive interconnection technology, in a form suitable for transfer to industry. Built an electronic system that demonstrates all the advantages of non-conductive interconnection technology in a realistic environment for one form of packaging.				
(U)	In FY 2005: Demonstrate the ability of an AC-coupled interconnect approach to be used in connecting two different parts of a complex system (i.e., third-level packaging.) Under this assumption, optimize the design of the interconnect to maximize signal transport efficiency and minimize the bit error rate due to misalignment and multiple mating cycles.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Magnetoresistive Random Access Memory (MRAM) Innovative	1.464	1.189	0.000	0.000

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	Communications Materials.				
(U)	In FY 2004: Developed and characterized a magnetic tunneling junction magnetic memory element 1 by 0.25 micron in size, along with supporting circuitry and architecture models, leading to distributed, radiation-hard, non-volatile memory for embedded and reconfigurable spacecraft computing systems.				
(U)	In FY 2005: Integrate MRAM cells, which are intrinsically radiation-hard, with RHBD microelectronics, leading to embedded memories for spacecraft systems that are more immune to single event upset effects from high energy particles. Support an unlimited number of read-write cycles with ten nanoseconds access time, while consuming less than a nonowatt per bit.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Advanced Life Cycle Cost (LCC)/Risk Model for Space Concept Development.	0.000	0.991	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Incorporate Space concept cost modeling processes and methodologies into a software modeling and simulation code, the Advanced LCC/Risk Estimating Tool, which will then be incorporated into an existing modeling and simulation tool to provide integrated design, analysis, and LCC/risk estimating.				
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Systematic Hierarchical Approach to Radiation Hardened Electronics.	0.000	1.487	0.000	0.000
(U)	In FY 2004: Not Applicable.				
(U)	In FY 2005: Develop RHBD process design kits (PDKs). PDKs are targeted at commercial, on-shore integrated circuit (IC) fabrication processes. Verify proper operation of PDKs against RHBD ICs generated for DoD space applications such as GPS receiver ICs. Fabricate and characterize radiation response of RHBD IC test chips and validate radiation characterization data versus simulated results. Provide standardized PDKs for the design phase of radiation hardened ICs. Provide accelerated potential for qualified, automated generation of hardened ICs during production phase.				
(U)	In FY 2006: Not Applicable.				
(U)	In FY 2007: Not Applicable.				
(U)					
(U)	CONGRESSIONAL ADD: Radiation Hardening Microelectronics.	0.000	1.388	0.000	0.000
(U)	In FY 2004: Not Applicable.				

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(U) In FY 2005: Develop and demonstrate next-generation electronics technology for DoD space systems applications using both design and process hardening techniques. Show that an emerging commercial electronics design can be rapidly transitioned to DoD space applications by taking advantage of the improved hardened fabrication industrial infrastructure and by modifying the design to harden against both natural and man-made radiation. Demonstrate sizes as low as 0.15 microns.
(U) In FY 2006: Not Applicable.
(U) In FY 2007: Not Applicable.
(U)

(U) CONGRESSIONAL ADDS: Intelligence Free Space Optical Communications and Intelligent Free Space Optical Satellite Communications Node.	0.000	2.974	0.000	0.000

(U) In FY 2004: Not Applicable.
(U) In FY 2005: Develop engineering model intra-satellite fiber optic communications network components, high speed, multi-channel, gimble-less inter-satellite free space optical communications transceivers, and intelligent/adaptive intra-satellite switching and routing components with initial space pre-qualification testing.
(U) In FY 2006: Not Applicable.
(U) In FY 2007: Not Applicable.

(U) Total Cost	32.515	26.787	18.966	18.891

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities: PE 0303601F, MILSTAR Satellite Communications System.										
(U) PE 0305160F, Defense Meteorological Satellite Program (DMSP).										
(U) PE 0602601F, Spacecraft Technology.										
(U) PE 0603311F, Ballistic Missile Technology.										
(U) PE 0603215C, Limited										

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(U) C. Other Program Funding Summary ($ in Millions)

Defense System.

(U) PE 0603218C, Research and Support.

PE 0603226E, Experimental

(U) Evaluation of Major Innovative Technologies.

PE 0604609F, Reliability and

(U) Maintainability Technology Insertion Program (RAMTIP).

This project has been coordinated through the

(U) Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification			DATE: February 2005
BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE: 3834 Integrated Space Technology Demonstrations	

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
3834	Integrated Space Technology Demonstrations	30.160	23.376	21.958	26.272	29.101	32.266	35.480	36.138	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project is a series of advanced technology demonstrations designed to address mission needs by applying emerging technologies from the Air Force Research Laboratory, other Government laboratories, and industry. These technologies are integrated into system-level demonstrations that are used to test, evaluate, and validate the technologies in an relevant environment.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop microsatellite (10-100Kg) technologies for integrated, robust, flexible, microsatellite demonstrations building on previous work and leveraging investments by other organizations. Applications include space-based space situational awareness and/or tactical satellite concepts.	21.861	18.420	21.958	26.272

(U) In FY 2004: Developed and tested a laser range finder subsystem. Developed and tested the ground control system for real-time planning and flight operations of proximity operations microsatellite. Tested autonomous operations software against simulated faults and anomalies. Completed system level integration of microsatellite and completed functional testing. Performed environmental testing and launch vehicle integration preparation and planning. Integrated ground control system and satellite software simulations. Performed simulated proximity operations missions for mission operations training and for determination of the simulated spacecraft performance and interaction with ground controllers.

(U) In FY 2005: Complete environmental testing. Complete development of autonomous proximity operations microsatellites ground control interface system. Perform real-time hardware-in-the-loop and software-in-the-loop mission experiments and testing beyond spacecraft envelope. Complete satellite/launch vehicle integration and launch. Perform mission operations around several non-cooperative resident space objects. Evaluate options for potential follow-on space situational awareness technology demonstration, using operational concept trades. Perform preliminary design concept trades and initial satellite design(s). Downselect to best payload option. Initiate satellite bus design. Complete preliminary bus and payload design.

(U) In FY 2006: Complete autonomous flight demonstration. Perform de-orbit maneuver. Complete satellite design(s). Initiate procurement of bus and payload hardware. Begin fabrication of payload and bus. Develop and test ground control system for real-time planning of flight operations of situational

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awareness missions. Develop and test flight software. Perform simulated missions against simulated faults and anomalies.

(U) In FY 2007: Complete payload and bus fabrication. Perform functional and environmental tests of payload and bus. Complete system level integration of payload and microsatellite and complete functional and environmental tests of integrated system. Begin integration with launch vehicle. Integrate ground control system and satellite software simulations. Perform simulated mission operations for missions operations training.

(U)

(U) CONGRESSIONAL ADD: AESIR Reusable Liquid Oxygen/Liquefied Natural Gas (LOX/LNG) Launch Vehicle Technology.	2.050	0.000	0.000	0.000

(U) In FY 2004: Fabricated and tested 30,000 pound thrust LOX/LNG engine to establish the feasibility of the basic propulsion concepts. This effort could lead to a relatively high performance, reusable 30,000 pound, pump-fed, regeneratively cooled chamber propulsion system and a two-stage-to-orbit vehicle system concept; effort could also lead to a reusable, configurable-plume propulsion system and target vehicle design. The target vehicle will be a relatively simple pressure-fed design to support plume detection and discrimination test objectives.

(U) In FY 2005: Not Applicable.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Integrated Spacecraft Engineering Tool (ISET).	1.660	0.991	0.000	0.000

(U) In FY 2004: Expanded the capabilities of an existing integrated engineering, modeling, simulation, and design tool that supports rapid modeling and collaborative Research, Development, Test, and Evaluation of advanced spacecraft and launch vehicles. Enhanced capabilities include modeling of more complex launch vehicle concepts, and vehicle atmospheric reentry performance for studies of future tactical conventional weapons delivery.

(U) In FY 2005: Expand to predict performance benefits and impacts for new technologies on a variety of spacecraft, spacelift, and responsive force systems. This includes unique subject areas such as satellite field-of-view studies, space radiation effects, directed energy lethality and vulnerability, and implementation of hardware-in-the-loop simulation.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Vehicle Risk Reduction.	4.589	3.965	0.000	0.000

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(U) In FY 2004: Validated the cost and performance of a rocket engine module used in the RSLV main propulsion system. Validated cost, mass properties, and structural performance of the RSLV segmented tanks through hardware fabrication and destructive testing. Demonstrated integrated operation of a segmented pair through ground hot fire testing.

(U) In FY 2005: Complete fabrication of all tank body component and assembly tools, fabrication of all tank body sections, fabrication of the structural test fixture, structural testing of the bodies, and fabrication of the tank dome component tools. Initiate completion of fabrication of both the remaining tank assembly tools and the remaining tanks.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U) Total Cost	30.160	23.376	21.958	26.272

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost

(U) Related Activities:

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603605F, Advanced Weapons Technology.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

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BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT NUMBER AND TITLE: 4400 Space Systems Protection

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
4400 Space Systems Protection	6.534	6.913	3.310	3.410	3.457	3.747	4.117	4.193	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates tools, instruments, and mitigation techniques required to assure operation of U.S. space assets in potentially hostile warfighting environments. The project performs assessments of critical components and subsystems, and evaluates susceptibility and vulnerability to RF and laser threats. This project also develops technologies that mitigate identified vulnerabilities. Technologies are developed and demonstrated to support balanced satellite protection strategies for detecting, avoiding, and operating in a hostile space environment.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Use multi-threat assessment tools to assess space-based electro-optical, communication, and other responses to various candidate RF and laser countermeasures and directed energy threats.	0.977	1.002	0.889	0.935
(U) In FY 2004: Enhanced existing satellite subsystem response data collection through laboratory test beds of satellite electro-optical sensor effects. Assessed electro-optical designs of planned space systems for RF and laser susceptibility and potential mitigation techniques. Assessed directed energy threat susceptibility and potential for mitigation techniques for key satellite subsystems, such as communications.				
(U) In FY 2005: Investigate models for RF and laser response in communications and power subsystems and integration into single satellite communications and power subsystem models into satellite constellation analysis tool. Apply constellation analysis tool to wargaming exercises and assess efficacy.				
(U) In FY 2006: Perform predicative analysis of laboratory data to validate models being developed for the satellite constellation analysis tool. Begin modeling of mitigation techniques and incorporate into constellation analysis tool.				
(U) In FY 2007: Verify mitigation models against test data and commence predictive analysis of technique effectiveness.				
(U)				
(U) MAJOR THRUST: Develop passive satellite countermeasures and mitigation techniques for current and future threats to satellites.	1.355	2.006	2.043	2.076
(U) In FY 2004: Completed plasma shield design and define potential system applications. Refined selected design trade studies and analyses to determine the impact of satellite self-protection and situational awareness technologies on space systems operations. Investigated mitigation technologies such as deployable shields and triggered automatic gain control for RF threats.				

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 4400 Space Systems Protection	

(U)	In FY 2005: Investigate and identify candidate threat mitigation technologies for principle satellite subsystems, such as shielding and terminal protection techniques for multi-chip modules, reconfigurable processors/architectures, and anti-jam modems for uplink subsystems.				
(U)	In FY 2006: Develop prospective threat technologies and initiate comprehensive testing for space application.				
(U)	In FY 2007: Integrate protection into space experiment for demonstration and validation.				
(U)					
(U)	MAJOR THRUST: Develop visible and near-infrared laser protection technologies.	0.785	0.435	0.378	0.399
(U)	In FY 2004: Investigated image interpretation processing techniques, Image Quality Measurement verse the National Image Interpretation System. Performed calibration of laser laboratory systems. Performed analysis of Thompson array testing in laser laboratory. Enhanced investigation of laser interference effects on readout electronics for new Kodak focal plane array sensor subsystem components.				
(U)	In FY 2005: Design and fabricate an optical sensor subsystem incorporating adaptive signal processing techniques. Develop optical sensor subsystem threat mitigation techniques using solutions such as acousto-optical switches or other developed limiters to deflect incoming laser energy from the focal plane array.				
(U)	In FY 2006: Demonstrate visible and near-infrared laser protection technologies. Conduct ground test of optical sensor subsystem incorporating selective mitigation approaches. Develop selected protection techniques and evaluate effectiveness as a laser mitigation technique of optical sensor subsystems. Coordinate space simulation testing of prospective protection technology.				
(U)	In FY 2007: Coordinate space demonstration of protective technology. Identify technology transfer opportunities and report findings to major commands.				
(U)					
(U)	CONGRESSIONAL ADD: Hardening Technologies for Satellite Protection.	3.417	3.470	0.000	0.000
(U)	In FY 2004: Examined, evaluated, and summarized potential protection techniques that are acceptable to systems designers, with a goal of minimal impacts of additional weight and power, integration issues, and performance loss. Established relationships with commercial system designers to explore acceptable approaches for applications to commercial systems. Began laboratory testing of prospective protection techniques, filters, rugates, and/or limiters applicable for enhanced survivability. Completed Version 1 of the Satellite Survivability Module code to include ability to analyze both RF and laser effects within the Satellite Toolkit framework.				
(U)	In FY 2005: Continue evaluation of possible protection techniques that are acceptable to systems designers with a goal of minimum impact of additional weight and power, integration issues, and performance loss. Maintain relationship with commercial systems designers to explore acceptable				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 4400 Space Systems Protection

approaches for application to commercial systems. Expand laboratory testing of prospective protection techniques, filters, rugates, and/or limiters applicable for enhanced survivability. Develop promising protection techniques emerging from FY 2004 effort. Begin development of field tests of the most promising protection techniques. Incorporate test results and feed back from commercial systems designers into the Satellite Survivability Module code.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U) Total Cost	6.534	6.913	3.310	3.410

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost

(U) Related Activities:

(U) PE 0602102F, Materials.

(U) PE 0602601F, Spacecraft Technology.

(U) PE 0603605F, Advanced Weapons Technology.

(U) This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2005

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT NUMBER AND TITLE: 5021 Space Systems Survivability

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5021 Space Systems Survivability	3.992	4.733	4.583	4.769	4.830	5.239	5.350	5.449	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates technologies to improve space system survivability and reliability of current and future Department of Defense space systems that must continue operation despite natural space hazards. It develops and demonstrates cost-effective solutions to mitigate hazardous space environmental interactions including electrical charge buildup and electronics failures due to both single radiation events and long-term radiation doses.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
	2.538	3.263	3.261	3.643

(U) MAJOR THRUST: Develop sensors to specify and forecast conditions in the space environment that degrade the operation of satellite, communication, navigation, and surveillance systems. Support integration, launch, validation, and operation of instrumentation to provide improved space radiation and ionospheric hazard specification and forecasting.

(U) In FY 2004: Validated solar disturbance forecast algorithms derived from all-sky heliospheric imager. Designed instrument and data plan for joint-agency mission to map the high-intensity region of the radiation belt that limits choices for spacecraft orbits. Expanded space weather forecasting system conceptual design to include interplanetary in situ plasma and magnetic field sensors in addition to miniaturized white-light camera. Developed initial micro- and nano-technology based concepts to miniaturize energetic particle, neutral density, and low energy plasma sensors needed to characterize space weather hazards.

(U) In FY 2005: Complete initial all-sky image based solar disturbance forecast algorithms and transition to military/civilian operational forecasters. Continue development of relativistic particle sensor for Air Force radiation belt mapping satellite. Investigate joint-agency development of miniaturized plasma, magnetic field, and all-sky white light cameras for inclusion on interplanetary microsatellites. Determine optimal micro- and nano-technology path to achieve maximum deployable, highest capability energetic particle, neutral density, and low-energy plasma sensors for space weather characterization.

(U) In FY 2006: Calibrate and integrate relativistic particle sensor onto Air Force radiation belt mapping satellite. Complete concept design for joint-agency space-based coronagraph and heliospheric imager for next-generation solar hazard detection system. Initiate concept design of micro- and nano-technology sensors for energetic particle, neutral density, low-energy plasma space weather characterization.

(U) In FY 2007: Complete integration of relativistic particle sensor onto Air Force radiation belt mapping satellite. Identify space test opportunity and begin construction of joint agency coronagraph and heliospheric imager for solar hazard detection. Complete concept design of next-generation miniaturized

Exhibit R-2a, RDT&E Project Justification			DATE: February 2005
BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE: 5021 Space Systems Survivability	

	space weather sensors and begin development of engineering models.				
(U)					
(U)	MAJOR THRUST: Conduct collaborative space and laboratory experiments and develop hardware and software tools to improve the survivability of spacecraft power, communications, navigation, and surveillance systems.	0.481	0.349	0.358	0.367
(U)	In FY 2004: Enhanced testing of miniaturized charge control system and began design of space experiment for the hazardous geosynchronous environment. Developed a space experiment concept to validate on-orbit electrical power generation and particle scattering capabilities of space tether. Developed initial suite of comprehensive spacecraft environment effect tools for operational use by integrating full range of environment specification and forecast models with spacecraft hazard, trans-ionospheric link degradation, and satellite drag specification tools. Investigated design of active antenna and passive detection hardware for space experiment to demonstrate techniques of lowering radiation belt intensities to protect satellites.				
(U)	In FY 2005: Complete design and laboratory testing of miniaturized geosynchronous charge control system and explore options for on-orbit demonstration of hazard mitigation. Refine space tether experiment concept and finalize space hardware requirements. Complete integration of ionospheric and satellite drag effects into spacecraft environment effect tool suite. Complete hardware suite selection and begin fabrication of payload for space experiment to actively explore space particle dynamics and demonstrate radiation belt remediation technologies.				
(U)	In FY 2006: Develop space plasma control experiment plan combining satellite charge control and tether propulsion and particle remediation concepts. Begin integration of dynamic space particle climatology and radiation belt forecast models into spacecraft environment effect tool suite. Continue fabrication of payload to demonstrate radiation belt remediation technologies using electromagnetic wave technologies.				
(U)	In FY 2007: Construct space plasma control experiment payload and establish joint-agency collaboration for spaceflight. Continue expansion of spacecraft environment effect tool suite to include dynamic space particle climatologies and forecast models. Complete radiation belt remediation payload and begin calibration and integration onto Air Force test satellite.				
(U)					
(U)	MAJOR THRUST: Develop technology to warn of spacecraft radiation, charging, and kinetic impact hazards and to provide space environment situational awareness and anomaly resolution capability for Department of Defense space systems.	0.973	1.121	0.964	0.759
(U)	In FY 2004: Completed development of first-generation data assimilation models specifying global radiation levels based on single compact environment anomaly sensor inputs. Completed concept design for space hazard detectors comprising distributed anomaly resolution sensors and begin hardware				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 5021 Space Systems Survivability

development. Refined detailed design of active wave and electron beam space experiment to demonstrate the feasibility of satellite protection technologies.

(U) In FY 2005: Advance global radiation hazard situational awareness model development by expanding number of sensor inputs to improve accuracy and timeliness. Complete laboratory demonstrations of distributed space hazard sensors needed for space situational awareness. Complete design of active wave experiment to remediate severe radiation environments. Plan for space test flight of active wave and distributed sensor technologies.

(U) In FY 2006: Develop filter-based optimization algorithms to determine full particle energy spectra utilizing complete inputs available from compact environment anomaly sensor. Determine impact sensor design and finalize requirements and conceptual design of radiation, plasma, chemical, and impact effect distributed anomaly resolution and spacecraft effects sensor suite. Complete construction of compact environment anomaly sensor to diagnose severe radiation environments expected during active wave radiation belt remediation experiment.

(U) In FY 2007: Employ full energy spectra algorithms to convert entire compact environment anomaly sensor data bases into dynamic climatological model for anomaly resolution and space system design. Commence construction of hardware for space demonstration of the distributed anomaly resolution sensor. Calibrate and integrate compact environment anomaly sensor for diagnosing severe radiation environment on Air Force test satellite.

(U) Total Cost	3.992	4.733	4.583	4.769

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) PE 0602601F, Spacecraft Technology.										

This project has been coordinated through the

(U) Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2005

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT NUMBER AND TITLE: 5083 Ballistic Missiles Technology

Cost ($ in Millions)		FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
5083	Ballistic Missiles Technology	6.274	6.798	5.491	3.859	3.928	4.248	4.327	4.397	Continuing	TBD
	Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops, integrates, and demonstrates advanced technologies for sustainment and modernization of strategic ballistic missiles. The project focuses on developing robust, low maintenance inertial navigation instruments to sustain current ballistic missile systems, as well as provide new, small, low-powered, high precision instrumentation for next generation missile systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Develop, integrate, and demonstrate advanced navigation instrumentation applied to emerging vehicle designs and other technologies that sustain current strategic missile systems. Provide critical missile technology concepts to support future space force application and strategic systems.	3.137	3.399	2.746	1.930
(U) In FY 2004: Evaluated the most promising navigation instrumentation technologies and integrated the advanced gyro and accelerometer systems into a breadboard demonstration of a reduced size and reduced power navigation instrument system that approaches or exceeds ballistic missile mission goals.				
(U) In FY 2005: Downselect to the most advanced navigational instrumentation designs for the next generation of ballistic missiles. Evaluate the designs and provide improvements to meet the established performance goals. Demonstrate and validate improved navigational technology designs that can meet performance goals.				
(U) In FY 2006: Explore further laboratory proof-of-concept of the most promising next generation missile navigation instrumentation designs. Initiate fabrication of navigation instruments and engineering demonstration units. Initiate engineering development tests. Evaluate instrument performance and provide improvements to meet established performance goals.				
(U) In FY 2007: Develop and integrate engineering design next generation missile navigation systems and ground test in environments relevant to subsequent flight test conditions. Evaluate system performance and provide improvements to meet established performance goals. Initiate flight test demonstration planning.				
(U)				
(U) MAJOR THRUST: Develop, integrate, and demonstrate advanced navigation technologies with new vehicle designs to provide robust, flexible, lower cost solutions for sustaining current strategic missile systems.	3.137	3.399	2.745	1.929
(U) In FY 2004: Integrated advanced thermal materials into long-glide vehicles to provide greater controllability and selective targeting. Demonstrated lower-cost, robust leading edge, and control surface				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 5083 Ballistic Missiles Technology

materials in a test flight to validate improved properties for future vehicle designs. Demonstrated that robust on-board navigation instruments and range safety devices can withstand loads greater than 100 times the gravitational force in all axes in laboratory tests.

(U) In FY 2005: Complete advanced thermal materials design integrated with long-glide vehicles to provide greater controllability and selective targeting. Evaluate demonstration results of advanced leading edge and control surface materials and initiate down selection to candidates projected to provide lower cost, robust advanced future vehicle designs. Use results of laboratory testing to improve the capability of on-board navigation instruments and range safety devices to withstand loads greater than 100 tiems the gravitational force in all axes in flight test demonstrations.

(U) In FY 2006: Initiate long-term plan for sled testing of high-gravitational force tolerant navigation instrumentation and range safety devices. Characterize instrumentation performance in quiescent environments. Initiate system level design interfaces with experimental test bed.

(U) In FY 2007: Continue long-term planning and initiate long-lead hardware acquisition and coordination with test facilities in preparation for sled testing of high-gravitational force tolerant navigation instrumentation and range safety devices. Measure performance of navigation instrumentation and range safety devices with associated platform hardware, power sources, support software, and communication interfaces in 100 times the gravitational force flight-like vibration environments. Continue system level design interfaces experimental test bed.

(U) Total Cost	6.274	6.798	5.491	3.859	

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) PE 0601102F, Defense Research Sciences.										
(U) PE 0602601F, Space Technology.										
(U) PE 0603311F, Ballistic Missile Technology.										
(U) PE 0603601F, Conventional Weapons Technology.										
(U) PE 0603851F, Intercontinental Ballistic Missile-Dem/Val.										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **5083 Ballistic Missiles Technology**

(U) C. Other Program Funding Summary ($ in Millions)

PE 0604851F,
(U) Intercontinental Ballistic
Missile-EMD.
PE 0605860F, Rocket System
(U) Launch Program-Space.
This project has been
coordinated through the
(U) Reliance process to
harmonize efforts and
eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

Exhibit R-2a, RDT&E Project Justification

DATE: February 2005

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603401F Advanced Spacecraft Technology

PROJECT NUMBER AND TITLE: 682J Spacecraft Vehicles

Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
682J Spacecraft Vehicles	26.082	21.232	6.607	10.020	11.858	10.281	13.065	13.301	Continuing	TBD
Quantity of RDT&E Articles	0	0	0	0	0	0	0	0		

(U) A. Mission Description and Budget Item Justification

This project develops and demonstrates compact, low-cost, spacecraft and launch vehicle power generation, storage, distribution, and thermal management technologies, including cryogenic cooling technologies. Power generation activities focus on lightweight, low-cost, low-volume, and survivable solar cell arrays. Energy storage work focuses on lightweight nickel hydrogen and sodium sulfur spacecraft batteries and flywheel energy storage systems for extended (five to ten year) satellite missions. The project's power distribution efforts focus on producing lightweight, high-efficiency, standardized power busses for use on future space systems.

(U) B. Accomplishments/Planned Program ($ in Millions)	FY 2004	FY 2005	FY 2006	FY 2007
(U) MAJOR THRUST: Developed and evaluated performance of space conventional power generation technologies such as multi-junction solar cells, advanced thin film solar cells, lightweight flexible solar cell arrays, and radiation resistant solar cell modules.	2.655	2.146	1.606	2.238
(U) In FY 2004: Demonstrated integration methods for thin-film solar cells on polymer substrates into full arrays. Completed full space qualification testing of 28% efficient solar cells. Integrated 28% efficient lattice mismatch multi-junction solar cells into test coupons.				
(U) In FY 2005: Demonstrate methods for interconnecting thin-film solar modules into array-sized thin-film blankets. Develop balloon-flight calibration samples for lattice mismatch solar cells.				
(U) In FY 2006: Complete space environmental testing of thin-film solar cells and modules. Perform radiation testing of lattice mismatch multi-junction solar cells.				
(U) In FY 2007: Perform radiation testing of five to six junction solar cells. Construct flight hardware for thin-film solar array. Demonstrate roll-to-roll production of thin-film solar cells on polymer substrates.				
(U)				
(U) MAJOR THRUST: Develop technologies for long life, efficient, low-vibration, lightweight mechanical cryocoolers and integration components for space applications.	1.633	1.263	1.046	1.470
(U) In FY 2004: Investigated development of high capacity, multi-stage, low temperature cryocooler system. Developed and characterized performance of second-generation designs model high capacity ten Kelvin cryocooler for advanced space surveillance and tracking sensor. Explored development of component cryocooler technologies for regenerative and recuperative cycle devices to transition enabling technology to cryocooler designs..				
(U) In FY 2005: Refine development of high capacity, multi-stage, low-temperature cryocooler technologies to meet the needs of high resolution, space-based infrared surveillance and tracking sensors with larger focal planes and optics. Expand development of component cryocooler technologies for regenerative and				

Exhibit R-2a, RDT&E Project Justification			DATE February 2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 682J Spacecraft Vehicles	

	recuperative cycle devices to transition enabling technology to cryocooler designs. Demonstrate cryogenic integration technologies, including thermal switches, in a relevant environment.				
(U)	In FY 2006: Complete development of low temperature flight qualified high capacity cryocooler and demonstrate performance of cryocooler and control electronics integrated with focal plane in a relevant environment. Improve performance of key critical components including compressor, electronics, and heat exchangers.				
(U)	In FY 2007: Assess various advanced technologies such as micro-electro-mechanical, optical cooling, and other concepts to further reduce cryocooler mass and improve performance for space based situational awareness applications. Initiate advanced concept development program to support multi-temperature and large focal plane cooling requirements for space-based space surveillance and other mission applications.				
(U)					
(U)	MAJOR THRUST: Develop composites for launch vehicle and spacecraft structures and space applications, such as launch vehicle shrouds, thermal protection structures, and space antennas.	5.212	2.335	1.973	3.327
(U)	In FY 2004: Refined spacecraft to demonstrate multi-functional structures technologies. Completed fabrication of multi-functional spacecraft bus components for small satellites. Flight qualified full-scale Evolved Expendable Launch Vehicle secondary payload adapter. Explored the design and characterized linerless composite cryogenic tanks. Developed large deployable optics structures using nanotechnology-enhanced materials.				
(U)	In FY 2005: Further refine spacecraft to demonstrate multi-functional structures technologies. Ground demonstrate sub-scale linerless composite cryogenic tanks. Fabricate and characterize components for large deployable optics systems using nanotechnology-enhanced materials.				
(U)	In FY 2006: Develop ultra-lightweight, high-structural efficiency mirror support structures for space mirrors. Demonstrate qualification-level performance of all-composite payload adapters and fairing structures for Evolved Expendable Launch Vehicles.				
(U)	In FY 2007: Demonstrate space qualification-level performance for large diameter launch vehicle fairing. Transition multi-functional structures technology to unmanned aerial vehicle and launch vehicle community. Demonstrate space qualification-level performance for 25-meters long ultralightweight deployable structures.				
(U)					
(U)	MAJOR THRUST: Develop technologies for spacecraft structural controls and mechanisms for on-orbit applications such as advanced high power solar array subsystems, sensitive payload isolation systems, and miniature payload isolation systems.	5.841	2.602	1.982	2.985
(U)	In FY 2004: Refined launch vibration isolation and primary and secondary payload isolation systems to				

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 682J Spacecraft Vehicles

meet specific launch vehicle requirements. Flight demonstrated operational active acoustic attenuation systems. Flight demonstrated low-shock multiple payload adapter technologies. Built deployment and isolation mechanisms for large free-flying solar array and integrated with thin film solar cell components. Designed flight hardware to demonstrate smart docking and deployment mechanisms. Developed micro-electro-mechanical attitude control components.

(U) In FY 2005: Refine launch vibration isolation and primary and secondary payload isolation systems to meet specific launch vehicle requirements. Complete development of operational active acoustic attenuation systems. Complete development of low-shock multiple payload adapter technologies. Perform flight qualification testing of smart docking and deployment hardware. Integrate micro-electro-mechanical attitude control components with conventional attitude control systems.

(U) In FY 2006: Develop rapid-slew, fast tracking gimbal technology to allow sub-orbital space situational awareness missions. Demonstrate space qualification-level performance for miniaturized vibration isolation systems for optical payloads.

(U) In FY 2007: Ground demonstrate full multi-axis flywheel attitude control system with integrated energy storage. Demonstrate space qualification-level performance for passive vibro-acoustic damping devices to mitigate launch vehicle acoustic loads. Flight demonstrate on-orbit docking and fluid transfer mechanisms.

(U)

(U) CONGRESSIONAL ADD: Thin Film Amorphous Solar Arrays.	4.590	7.434	0.000	0.000

(U) In FY 2004: Developed monolithic integration technology for the low-cost interconnection of thin film amorphous silicon solar cells. Developed lightweight solar array support structures and deployment mechanisms enabled by the thin film solar cells. Demonstrated the reproducible manufacture of large-area amorphous silicon cells necessary for population of the thin film solar arrays.

(U) In FY 2005: Demonstrate monolithic integration of amorphous silicon solar cells in roll-to-roll processing. Demonstrate process capable of high volume, roll-to-roll production of amorphous silicon solar cells on polymer substrates.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Robust Aerospace Composite Materials/Structures.	2.734	4.461	0.000	0.000

(U) In FY 2004: Furthered efforts to develop larger fairings for expendable rockets. Refined the design, analysis, and fabrication techniques for very large payload fairings through the development of sub-scale components and test articles.

(U) In FY 2005: Fabricate full-scale fairings and adapters based on design inputs from FY 2004 and

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY 03 Advanced Technology Development (ATD)	PE NUMBER AND TITLE 0603401F Advanced Spacecraft Technology	PROJECT NUMBER AND TITLE 682J Spacecraft Vehicles

supporting Small Business Innovation Research contracts for new structure fabrication processes and fairing/adapter configurations. Demonstrate large scale out-of-autoclave component fabrications. Investigate influence on practical controlled flaws and performance. Test structures to failure to demonstrate degree of conservatism in current design practices. Fairing designs up to ten meters in diameter to support large optics experiments will be considered for this demonstration program.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U)

(U) CONGRESSIONAL ADD: Boron Energy Cell Development.	3.417	0.991	0.000	0.000

(U) In FY 2004: Increased energy conversion efficiency of the Boron Energy Cell, which converts radioisotope beta emissions into electric current. Quantified mission impacts for Department of Defense applications.

(U) In FY 2005: Integrate Boron Energy Cell with battery and capacitor storage device to provide Boron Energy Cell Storage Packs capable of supplying burst power for selected high value Air Force applications.

(U) In FY 2006: Not Applicable.

(U) In FY 2007: Not Applicable.

(U) Total Cost	26.082	21.232	6.607	10.020

(U) C. Other Program Funding Summary ($ in Millions)

	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total Cost
(U) Related Activities:										
(U) PE 0602203F, Aerospace Propulsion.										
(U) PE 0602601F, Spacecraft Technology.										
(U) PE 0603218C, Research and Support.										
(U) PE 0603226E, Experimental Evaluation of Major Innovative Technologies.										
(U) PE 0603500F, Multi-Disciplinary Advanced										

Exhibit R-2a, RDT&E Project Justification		DATE February 2005
BUDGET ACTIVITY **03 Advanced Technology Development (ATD)**	PE NUMBER AND TITLE **0603401F Advanced Spacecraft Technology**	PROJECT NUMBER AND TITLE **682J Spacecraft Vehicles**

(U) C. Other Program Funding Summary ($ in Millions)

(U) Development Space Technology. This project has been coordinated through the Reliance process to harmonize efforts and eliminate duplication.

(U) D. Acquisition Strategy

Not Applicable.

PE NUMBER: 0603444F
PE TITLE: MAUI SPACE SURVEILLANCE SYSTEM

Exhibit R-2, RDT&E Budget Item Justification

DATE: February 2005

BUDGET ACTIVITY: 03 Advanced Technology Development (ATD)

PE NUMBER AND TITLE: 0603444F MAUI SPACE SURVEILLANCE SYSTEM

	Cost ($ in Millions)	FY 2004 Actual	FY 2005 Estimate	FY 2006 Estimate	FY 2007 Estimate	FY 2008 Estimate	FY 2009 Estimate	FY 2010 Estimate	FY 2011 Estimate	Cost to Complete	Total
	Total Program Element (PE) Cost	50.208	58.189	5.848	6.005	6.082	6.596	6.735	6.860	Continuing	TBD
4868	Maui Space Surveillance System	50.208	58.189	5.848	6.005	6.082	6.596	6.735	6.860	Continuing	TBD

(U) A. Mission Description and Budget Item Justification

This program funds space situational awareness technology development and demonstration at the Maui Space Surveillance System (MSSS) in Hawaii, as well as the operation and upgrade of the facility. Note: In FY 2005, Congress added $33.9 million for the MSSS, $8.5 million for High Accuracy Network Determination System, and $10.0 million for Panoramic Survey Telescope And Rapid Response System (Pan-STARRS).

This program is in Budget Activity 3, Advanced Technology Development, since it enables and demonstrates technologies for existing system upgrades and/or new system developments that have military utility and address warfighter needs.

(U) B. Program Change Summary ($ in Millions)

		FY 2004	FY 2005	FY 2006	FY 2007
(U)	Previous President's Budget	51.581	6.306	6.323	6.405
(U)	Current PBR/President's Budget	50.208	58.189	5.848	6.005
(U)	Total Adjustments	-1.373	51.883		
(U)	Congressional Program Reductions				
	Congressional Rescissions		-0.517		
	Congressional Increases		52.400		
	Reprogrammings	-0.107			
	SBIR/STTR Transfer	-1.266			
(U)	Significant Program Changes:				

Not Applicable.

C. Performance Metrics

Under Development.